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degree of accuracy required) beyond the number that are to be retained and tabulated. The effect is, that in computing to two places beyond the number required for tabulation, our knowledge of the possibility of an error of say 3, in the last of them, will only leave us in doubt, in the few cases in which the extra figures are between 47 and 53, whether the usual conventional increase is due to the last figure retained or not. And if we go to three extra places the doubtful cases, for a possible error of 3, will be between the limits 497 and 503. Hence if the facility for the occurrence of the possible error for all points of the series were the same, we should probably have in the first case, three instances in every hundred of the values formed, and in the second three in every thousand, in which the increase is wrongly given or withheld. Such an amount of liability to error as this will not disturb the equanimity of either the most timid computer, or the greatest stickler for accuracy.

(151). The preliminary matter being now disposed of, we are ready to enter upon examples of the actual construction of tables. The first example will be a table of Anti-logarithms, that is, of the numbers corresponding to all logarithms from 0 to 1.

The Mutual Life Insurance Company of New York.

ON the 1st February, 1868, this Company, "now the largest moneyed Corporation" in America, celebrated its "silver wedding," as it was termed by the Governor of the State of New York on the occasion of the 25th annual meeting. The Report then presented and the general Prospectus of the Company have been forwarded to us by the "President" of the Company, who appears to be virtually what in this country we should call "Managing Director." These documents are so instructive and interesting in themselves, and illustrate so remarkably the application to our pursuits of that originality of the American character, which is fast becoming as proverbial as its energy, that we propose to notice their contents in some detail.

Though most of us have a vague notion that the operations of American Insurance Companies are conducted on a scale of great magnitude, few will learn without astonishment that this particular company alone issued, in its last financial year, no fewer than 19,406 Policies, for sums amounting in the aggregate to over

twelve millions sterling (\$62,252,606), on which more than *eight hundred thousand pounds* (\$4,007,064 10) were paid as "original or first year's premiums." There is danger of our failing to grasp the meaning of these figures. They mean that a new business was brought together, in one year, double and even treble in amount the whole accumulated business of many of our oldest Offices, and, with but one or two notable exceptions, exceeding that of any Office in the United Kingdom, of whatever age or standing. It must, however, be borne in mind that a deduction is to be made from these and the other figures we shall give, on account of the depreciation of the paper currency of the United States.

At the date of the Report, the total business consisted of 52,384 Policies, assuring, with bonus additions, £38,868,323. To meet this liability there were assets to the amount of £5,063,864, and an Annual Income of £2,034,609, of which £1,771,457 was derived from premiums and £263,152 from interest on investments. The assets were made up of £4,532,490 actual funds and £531,374 miscellaneous items, chiefly unpaid premiums and interest, but including two that deserve notice, one being a sum of £99,988—equal to 10 per cent on the original investment—for "Market Value of Stocks in excess of cost," and one a sum of £109,451 for "Value of Future Commissions commuted"—an item of somewhat questionable propriety.

These Assets, it will be seen, are somewhat less than three years' premium Income, and less than 13 per cent of the gross Liabilities. This indicates a recent business; and indeed, the total Income has quintupled itself in the last four years. Since the close of the Civil War this Company, like most other American Institutions of the kind, has entered on a new and remarkable epoch. Year by year, during the last four years, the new premium Income has increased in almost geometric progression. In 1864, it was £55,805; in 1865, £109,116; in 1866, £230,813; in 1867, £435,388; in 1868, £801,413.

These almost incredible results have been achieved by an Office founded but 25 years ago, in a "rear room" in Wall Street, whose "new system," as it then was in America, "of Mutual Assurance" was regarded with so much apathy and distrust, "that a large number of the original Subscribers failed to take their Policies, and their places were supplied by others."

Results so extraordinary cannot have been brought about by ordinary means. By the adoption of 4 per cent as the rate of interest, the Company is certainly able to put before the American

public more tempting rates of premium for the earlier assuring ages than those to which the English public is accustomed. But this alone will not suffice for an explanation. There are, in our opinion, two principal causes—one due to the economic condition, and the other to the genius of the American people; the former being the rate of interest at which money can be improved, the latter, the introduction of what are known as “ten year non-forfeiture Policies,” the peculiarity of which is that “if, after two annual premiums have been paid, further payments are to be discontinued, the holder may, upon due surrender of the original policy, in accordance with the rules of the Company, receive in lieu thereof a paid-up policy for as many tenth parts of the original sum insured as full annual premiums have been paid.” To these causes the Prospectus before us adds a third, viz., the introduction of the system known here as that of “Endowment Assurance”—a system, the prospectus states, “better adapted to the wants of the American people than any other,” as is shown, it says, by the fact that “of over £7,000,000 received last year in cash by the total number of American Companies we estimate over one half to be paid for Endowment premiums.”

The New York Mutual Company adopted this system no longer ago than 1854, and that of non-forfeiture Policies so lately as 1858, and yet out of its total number of 52,384 Policies, 19,711 are on one or other of these plans or on a combination of the two. The growing and also the relative popularity of these systems may be seen in the details given of the business of 1867. Of its 15,993 new Policies, 7,431 only, or less than one half, were ordinary, continuous-premium assurances; of the remainder, 2,652 were life Policies on the non-forfeiture plan, 4,305 were ordinary endowments, and 1,605 ten-year endowments. We here see the cause of the high rate of premium—very nearly $6\frac{1}{2}$ per cent—which is so noticeable in the returns of American Companies.

It cannot be doubted that neither of these systems carries out in its integrity the fundamental ideas of life assurance—(1) that assurance is for the benefit, not of the Life assured, but of those dependent on him; (2) that the best form of assurance is that which gives the largest contingent guarantee for the smallest immediate outlay. On the other hand there need be no difficulty in understanding why these two systems should be popular. The argument put forward for the ten-year system is in one view irresistible. There can be no doubt that there is “an obvious advantage in paying for an insurance during the productive period of life.” Happily however this productive period is not limited to 5,

10 or even 15 years—the longest period, apparently, over which the payments under the non-forfeiture plan are made to extend. It is therefore possible, by making the productive period and the period of payment contemporaneous, to combine, in the highest degree, the two advantages of small premiums and the ability to pay them. It is to Assurance in this form that English Companies will have next to address themselves. As regards the Endowment system, the source of its popularity is obvious when we are told that “all Endowments that have thus far matured during life of the insured in this Company have proved equal to six per cent compound-interest investments, costing nothing for insurance or expense meanwhile.”

Here we come upon what after all mainly accounts for the results we have detailed, upon that which has, in fact, been the main cause of the Company's success, viz., the rate of interest which it has been able to realize. In the paper by Mr. Sheppard Homans, to be found in the 11th vol. of this *Journal*, in which he explained the system devised by him for an equitable distribution of surplus, he stated that up to that time (1865) the net rate of interest realized by the New York Mutual Insurance Company had been $6\frac{1}{2}$ per cent. It is now said to have been 7 per cent net over the whole 25 years. The rate current in recent years must therefore have been still higher. Let us see what the Company has consequently been able to do for its Policyholders. We cannot do better than transfer to our pages the particular illustration which the Company itself gives.

POLICY No. 487.

Amount \$5000. Dated February 12th, 1844. Age 40.

ORDINARY LIFE PLAN. ANNUAL PREMIUM \$160.00.

Dividend Dates.	No. of Premiums paid.	Amount of Premiums paid.	Cash Value of Dividends when made.	Percentage on Premiums.	Additions for Dividends.
Dividend of 1848,	4	\$640 00	\$174 30	27	\$431 64
“ “ 1853,	5	800 00	227 66	28	499 59
“ “ 1858,	5	800 00	351 12	44	682 71
“ “ 1863,	5	800 00	783 30	98	1356 37
“ “ 1866,	3	480 00	589 64	123	956 27
“ “ 1867,	1	160 00	190 47	118	302 49
“ “ 1868,	1	160 00	201 04	126	312 81
	24	\$3840 00	\$2517 53	Average $65\frac{1}{2}$	\$4541 88

THE PAST.

Total Premiums paid in 24 years, . . . \$3840 00
 Total Cash value of Dividends, . . . 2517 53
 Dividends average 65 per cent.

THE PRESENT.

Original Policy, \$5000 00
 Additions, February 12th, 1868, 4541 88
 Total Insurance, \$9541 88

THE FUTURE.

No more Premiums are required in cash. The Annual Dividends are likely to exceed the Annual Premiums. The excess will be applied at option of the assured, to increase Policy, or as an *annual cash income*.

This example needs no comment. It may be well, however, to add, by way of increasing our astonishment, if that be possible, that to meet their liability under this Policy they reserve \$5094, \$2175 on account of the sum assured and \$2919 an account of its bonus additions, although the total amount received as premiums is only \$3840! Speaking in general terms, the Company thus details the benefits they have been able to procure for their assured. "The experience of the Company thus far shows the extraordinary result, that after ten or twelve full annual premium payments on an ordinary Life Policy, the owner may keep the same in force without further cash payments, by simply *surrendering and slowly consuming* his former additions, while fifteen or eighteen full payments generally have sufficed to keep both policy and additions in force for the full amount by the annual cash dividends."*

It is not unnatural that they should themselves view their success with fear and trembling. They wisely warn their constituents "that if the rate of interest should fall in future below what it has been in the past less favorable results must be expected."

The Report contains what, to English eyes, appears a very novel feature. There is appended a mathematical demonstration of their method of dividing surplus. This plan is already familiar to actuaries, being a modified and simpler form of that given by Mr. Homans in the paper above referred to. It will be remembered that in that paper, the demonstration was for a quinquennial distribution, and sufficiently complicated it was. It may not, perhaps, be too much to say that the necessities of his plan compelled his Office to adopt their present system of annual divisions. By this means, at all events, much complication has been got rid of; and we freely confess at the same time that the method of annual divisions is far more suitable to Companies showing such rapid progress as the one we are considering, than it would be to the more steady-going English Offices. The resulting formula, by means of which the share of surplus attaching to each policy is determined, is this :

$$V_{x|n}(1+i') + (P_x - e)(1+i') - \frac{d_{x+n}}{l_{x+n}}(1 - V_{x|n+1}) - V_{x|n+1} = \chi_{x,n}$$

= contribution to surplus.

* The practice of the Company as to the surrender of the reversionary bonuses is, we believe, far more liberal than that of any English Office; for at any time, a sufficient portion of the bonus may be surrendered to pay the current premium.

Here $V_{x|n}$ = the reserve fund at the beginning of the year of observation; P_x , the actual premium; e , the share of expenses chargeable on the Policy; i' , the actual, as distinguished from i the assumed, rate of interest; and $\frac{d'_{x+n}}{v_{x+n}}$, the contribution to the death fund of the year as deduced from the actual deaths amongst all the living of the particular age of the individual Policyholder. The surplus being mainly derived 1° from excess of actual over estimated interest, 2° from diminished mortality, and 3° from unexpended loading, the object of the method, as is well known, is to return to each Policyholder such portion of each of these items of surplus as rightly belongs to him. Stated in words, the plan is thus described in the *Journal* (vol. xi., page 124): “*Credit each Policyholder, 1st with the amount actually reserved at the last preceding distribution of surplus as the then present value or re-insurance of the Policy; and 2nd, with the effective (or full) premiums paid since that time, both sums being accumulated at the actual current rate of interest to the date of the present distribution; and charge him, 1st, with the actual cost of the risk to which the Company has been exposed during the interval, determined by means of a table representing the rates of mortality and interest actually experienced; and, 2nd, with the amount now reserved as the present value of the Policy. The difference between the sum of his credits and the sum of his debits determines the over-payment or contribution from the Policy proper.*” Though not expressly stated here, it will be seen that the formula, in determining the cost of insurance, takes account only of the amount actually at risk, of the difference, that is, between the sum in the Policy and the reserve. By this means, to use their own words, “the cost of insurance may, and in many cases actually does, decrease each year, notwithstanding the increased age of the insured!”

The Author of this plan naturally claims for it a high degree of merit, and points, with excusable pride, to the fact that already twenty Companies in America follow it, adding that other Companies “will be compelled to adopt it as soon as the needed preparatory changes in their system can be made.” We cannot, however, admit that he is at all justified in saying that “this method is now acknowledged by all the leading mathematicians of both parts of the world to be the only equitable plan of distributing surplus.” On the contrary, judging from our recollections of the discussion that followed the reading of Mr. Homans’s paper before the Institute of Actuaries, we should say that the method was

received with very little favour by English actuaries; and in evidence of this we have only to quote Mr. Jellicoe's words in summing up that debate:—"I think I may pronounce, *ex cathedra*, and at all events with a considerable degree of certainty, that you would accept the truth of the proposition that to give each person a share of the surplus in proportion to the number and amount of premiums he has paid in the interval, is really sufficient to deal out strict justice to all." And so far from there being any general consent that all other methods of distribution are inequitable, as would of course follow from the words we have quoted, it is well known that there are many actuaries who, looking at the matter in a broad sense, emphatically protest against branding as inequitable or untrue any method of distribution that is intelligible in itself and clearly put before those who are to be bound by it. It is after all (they say) a matter of contract. What may be mathematically true may be commercially undesirable. In the language of Professor De Morgan, quoted by Mr. Gray at a discussion at the Institute in March, 1864, "Whatever method is to be used, let it be known, and all will be right." Without going so far as this, many others are of opinion that widely different methods of distribution may be considered in every sense as equally equitable: as for example, that which appropriates all the profits to those policies on which the premiums received accumulated at compound interest exceed the sum assured, and that which makes the same proportionate addition to all policies becoming claims in the same official year.

For ourselves, while admitting that Mr. Homans's plan is a great improvement on the method which divides the surplus in proportion to the premium paid,—which method we learn from the prospectus prevails in most of the mutual Companies of the United States, and prevailed "in all till the introduction of the contribution plan of dividends by the Mutual Life in 1862"—we are of opinion that the method falls very far short of perfect equity, inasmuch as it makes the same charge for the current assurance of all the assured of the same age, whatever the length of time they have been on the Office books; and the assured of long standing thus share unduly, and therefore inequitably, in the profit from the reduced mortality consequent on the large influx of recently selected lives. Nor can the method be considered as satisfactory in other respects until a practical rule is given for the assessment of the proper share of the expenses to each policyholder. It is said "The equitable apportionment of the *expenses* of business

among the various policy-holders, especially when the sum total of the *contributions* [or over-payments] is greater than the total Surplus to be divided, is a difficult and delicate problem, upon which no specific directions can be given—the peculiarities of each Company requiring special treatment.”

There are numerous peculiarities of practice in the New York Mutual Insurance Company—as compared with English Offices—which are well worth notice, but to which we can only briefly refer.

Their business is confined to what the Prospectus terms “the salubrious districts of the United States.” It is stated emphatically that “risks in the South are not sought and no Agencies opened where extra premiums are necessary.” The proposals are accepted, by the President alone, if, in his opinion, the evidence is “clear from all objections,” or in consultation with the medical officers, if there be doubt. The maximum amount to be assured on one life is fixed at the small sum of £4,000 (\$20,000); and, carrying boldly into practice a belief we in this country are as yet but learning to accept in theory, they charge, on ordinary life policies, for ages under 25, the same premium as for age 25. They moreover require an (apparently annual) extra premium of 10s. per cent on the sum assured for assurances on female lives between the ages 18 and 48, the childbearing period. The “Office age” is always taken as the age at the nearest (not the next) birthday. All policies issued, of whatever description, share in the profits—there are however apparently no short term policies granted.

On the other hand, we learn with surprise that the New York Mutual Office is singular among the American Offices in declaring reversionary bonuses on its policies.

The greatest care is shown in dealing with the Investments. “The Charter of the Company permits no speculation of any kind.” United States Stock, Stock of the State of New York, and Bonds and Mortgages of real property in New York State, “worth in every case double the amount loaned,” form their only securities. The Stock, they obtain by subscription and directly from the Government; all applications for loans on real estate, and all certificates of appraisers and others as to the value of the property to be pledged, are made *on oath*; whilst “to guard against any possible loss from the depreciation of property, the bonds and mortgages are drawn for one year, so that the Company can speedily collect its loans if necessary.” Like caution, indicating

that there still lingers in the State that distrust of men in one another so peculiar to unsettled countries, is shown in the double audit to which the receipts and disbursements are subjected.

They seem to have anticipated Mr. Bunyon in what they term "the Instalment Feature," a system under which a claim by death is paid by fixed Instalments spread over a term of years to be agreed upon, the balance remaining with the Company at the end of each year receiving a stipulated rate of interest. The Company thus becomes "the Guardian or Trustee of the Survivors," and hence "the provision may be considered, humanly speaking, beyond any adverse contingency." These policies may be made "inalienable," if desired; as also may Policies granted to married women on the lives of their husbands under the authority of a special enactment of the State of New York, and by virtue of which such Policies are free from claims by the creditors or representatives of the Husband.

We are not surprised to find that in all points of settled usage this Company is behind us in liberality. "All premiums are due and payable at the office of the Company, in the City of New York," and though payment to an Agent is allowed, the privilege is fenced round with various restrictions that again mark distrust, and this provision appears to have operated very harshly during the late Civil War. No days of grace are allowed, and restoration of Policies is permitted "solely as an act of grace or courtesy, and when the interests of the Company will not be impaired in any way thereby." Applications for restoration "must invariably be accompanied by a certificate as to the health of the person whose life was insured, and at his expense, from a physician acceptable to the Company," whilst the Policy, if revived, becomes subject, "in accordance with the decision of the Internal Revenue Department, to stamp tax for the same amount as that required for a new Policy." This cost, also, the assured has to bear. Claims are paid sixty days after proof of death.

One reflection is forced on us by what has preceded. How long will it be before the Insurance tide which has so long set westward shall be rolled back on our own shores? When it comes, if it should come, how shall we be able to withstand it? We can do nothing for our Policyholders that will bear a moment's comparison with the results which this Company has accomplished and, we cannot doubt, will continue for many years to come to accomplish for them. At present we are safe in the merited distrust which hangs about the public credit of the country. But

old stains, if not renewed, will assuredly be worn out with time. Let its public credit be once established beyond reach of doubt or cavil, and America must become the savings bank of Europe, and certainly not least so in respect of such savings as take the form of Assurance premiums.

INSTITUTE OF ACTUARIES.

PROCEEDINGS OF THE INSTITUTE.—SESSION 1867-68.

First Ordinary Meeting, Monday, 25th November, 1867

The President in the Chair.

Read and confirmed the minutes of the last ordinary meeting.
The following gentleman was elected a Fellow, viz.:—

Andrew Baden.

The President read a report of the Sixth International Statistical Congress held at Florence.

Mr. T. B. Sprague, M.A., read a paper by Mr. Jardine Henry, entitled “Memoir on Instrument for furnishing the D numbers, to four figures each, in Two-Joint-Life Annuity Tables on any basis.”

Thanks having been voted to the President, Mr. Sprague, and Mr. Jardine Henry, the meeting adjourned to Monday, 30th December, 1867.

Second Ordinary Meeting, Monday, 30th December, 1867.

The President in the Chair.

Read and confirmed the minutes of the last ordinary meeting.
The following gentlemen were elected, viz.:—

Fellows.

Frederick J. Elderton.

William Wallis.

Associates.

Felix Bassett.

Thomas John Barnes.

Henry Milner Blundell.

David Carment.

David Deuchar.

Walter Maples Edwards.

Samuel Hunter.

Nathaniel Jellicoe.

Joseph Henry Mayor.

William Rae Macdonald.

Ronald McPherson.

Charles W. B. Oak.

Franklyn Pennington.

James Watson Rodger.

Clarence Smith.

Mr. J. Hill Williams read a paper “On Briggs’s Method of Interpolation.”

Thanks having been voted to Mr. J. Hill Williams, the meeting adjourned to Monday, 27th January, 1868.